—Markets 4. Issued June 8, 1917.

United States Department of Agriculture,

OFFICE OF MARKETS AND RURAL ORGANIZATION.

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PRELIMINARY REPORT ON APPLE-PACKING HOUSES IN THE NORTHWEST.

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INTRODUCTION.

In the States of Washington and Oregon during the apple-packing season of 1916 this office conducted an investigation of the handling of apples from the orchard to and through the packing house and into the cars ready for shipment to market. This work was undertaken at the solicitation of various fruit-growers' associations and individuals who urged the need of assistance in working out efficient and economical methods of handling apples through the packing house. The prospective increase in the production of fruit in the Pacific Northwest as the orchards grow older, and the growing scarcity of labor for handling large quantities of fruit in so short a period, greatly emphasize the importance of this problem.

The investigations centered around community or central packing houses, which are growing in popularity and which give promise of greatly facilitating the handling of the apple crop. Until 1916 the handling of apples through community houses had not been practiced to any considerable extent, and the best methods to be employed had not been determined. In 1916 many new houses were built for this purpose and put into operation. The size of house required to handle a given quantity of fruit was largely a matter of speculation, and the equipment necessary for the best and most economical results

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had not been determined, so that the venture was, in part at least, experimental.

The purpose of the investigation was to determine the best and most economical methods of handling apples through all the operations of picking, hauling from the orchard, receiving at the packing house, grading, sizing, packing, storing, and loading on the cars. This involved a study of packing-house plans, location, equipment, management, cost of operation, and storage facilities.

Owing to unfavorable conditions that developed after the season opened, some of the detailed experiments contemplated in the original plan could not be carried out. The scarcity of labor and the shortage of cars for moving the fruit to market resulted in a congested condition in all of the packing houses visited and considerable confusion in some of them. It became necessary, therefore, to limit the work largely to the making of observations and conducting such tests as would not interfere in any way with the packing-house operations.

A floor plan showing the arrangement of the equipment was made of each of the more important houses and facilities for storing packed and unpacked fruit were noted. Sizing machines were tested for accuracy and efficiency and for their effect on the physical condition of the fruit. Methods of handling the fruit through every operation from the receiving door to the car were studied, and the efficiency of the different methods compared. Individual or ranch packing houses and operations were included in the investigations, so that the efficiency and economy of the two systems might be compared.

The investigations were conducted in 60 packing houses located at or near Spokane, North Yakima, Wenatchee, Cashmere, Entiat, Pateros, Brewster, Okanogan, Omak, and Walla Walla, Wash.; and Hood River and Medford, Oreg. Of these 60 houses, 33 were operated as community houses, 7 were operated by dealers somewhat on the community plan, and 20 were ranch houses. Although observations were made in all of the 60 houses visited, only the more important were investigated in detail.

It would be unwise to attempt to draw definite conclusions from a single season's work on a problem of this kind, and it is not the purpose of this publication to do so, but rather to furnish interested organizations and individuals with such of the information obtained as may be of value in connection with the construction and equipping of new houses and the reorganizing and rearranging of old ones.

COMMUNITY PACKING HOUSES.

The conditions existing in the principal apple-growing districts of the Northwest make the handling of apples through community

or central packing houses more desirable and more practicable there than in the East. The fruit interests of the Northwest are located largely in numerous small areas where a central packing plant can accommodate a large number of growers, and with few exceptions the orchards are comparatively small, ranging mostly from 5 to 15 acres.

It is estimated that about one-fourth of the 1916 apple crop of Washington and Oregon was packed in community houses, although no definite figures are available to substantiate this assumption. The community packing-house idea is growing rapidly, and it seems probable that within the next few years most of the apples grown in the Northwest will be packed in such houses. The labor situation renders it increasingly difficult to handle the fruit properly at the growers' ranches. Apparently the organization of labor and facilities must fall more and more into the hands of associations with capital sufficient to provide buildings and appliances for the efficient handling of the crop. One of the most pressing needs observed is the necessity for the better housing and subsisting of the force, but this is aside from the subject under consideration, except that it appears to be one of the factors which will operate toward centralization of the work. The advantages of the community over the individual or ranch plan may be briefly stated as follows:

Better and more uniform grading and packing can be obtained with an efficient organization of trained men handling a large quantity of fruit than with a number of small units operating independently.

The central packing plant is in a better position to cope with the labor problem than is the individual grower. It can obtain experienced labor more readily and can use inexperienced labor more effectively. In community packing schools local men, women, and children can be trained quickly to do good work under competent supervision. The individual grower usually is not able to supply the strict supervision necessary to obtain the best results from such labor.

The handling of a large quantity of fruit through one central plant makes possible the use of expensive labor-saving equipment, such as sizing machines and gravity conveyors, which the small grower could not well afford. Such equipment, although not essential, greatly facilitates the handling of the crop.

The central plant also simplifies and facilitates the inspection work which is one of the essentials in the successful marketing of the crop. One inspector in a community house can accomplish the same work that would require several inspectors working in the orchards, and he can do it more thoroughly.

It should be stated, however, that instances were observed where the individual grower was doing fully as good work as the community organization, and apparently at no greater cost. This was particularly true of some of the growers whose operations were sufficiently large to warrant the employment of competent foremen and

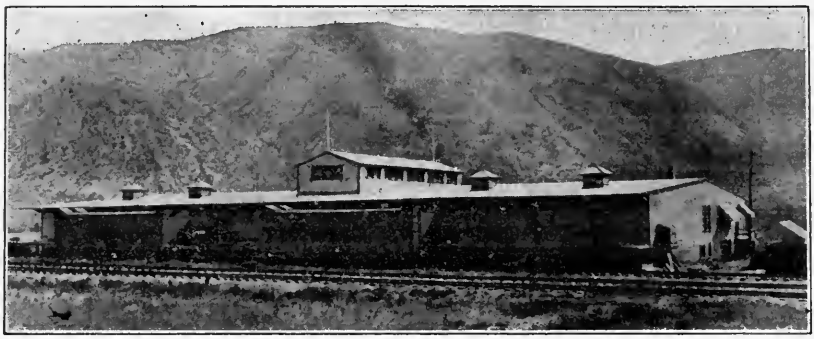

FIG. 1.—A community packing house with the operating space in the center under the penthouse structure and the storage space in each end on the railroad side.

the use of suitable equipment, but even smaller growers here and there were doing excellent work without special equipment.

Of the 40 houses used for community and commercial packing, 23 were built primarily for packing apples (fig. 1), while in two cases tents were used (fig. 2), and in 15 cases warehouses, old canneries, and other buildings had been converted temporarily into packing

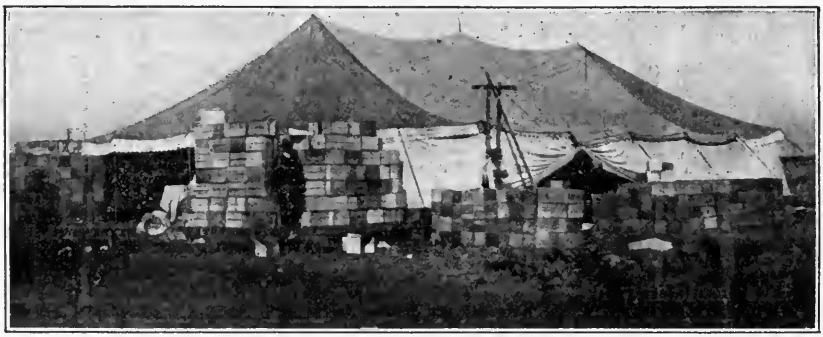

FIG. 2.—Tent used for community packing, showing an accumulation of loose fruit outside.

houses. Thirty-five of the houses were located on railroad sidings and 5 away from the railroad; 27 had common storage and 5 had cold-storage facilities connected, while 8 had no storage facilities.

Of the 23 houses built for packing purposes 14 were constructed of wood, 6 of hollow tile, 2 of brick, and 1 of concrete. The 23 permanent packing houses ranged in size from 20 by 60 feet to 86 by 300 feet. The dimensions of approximately 60 by 100 feet were more

common than any other, and there were about as many larger houses as smaller.

The capacity of the house is not necessarily determined by the size of the floor space. The equipment used, its arrangement on the floor, the efficiency of the working force, and the space occupied by unpacked fruit are all important factors. A certain house with 1,200 square feet of floor space was packing 600 boxes daily, while another house with 2,400 square feet was packing only 400 boxes. A certain other house with 6,000 square feet of space was packing 1,400 boxes a day, while another of double the floor space was packing only 1,800 boxes, and still another with 24,000 square feet of space was packing only 1,500 boxes. It appears from the observations made that a house with 5,000 square feet of floor space properly equipped and arranged would accommodate a daily output of 1,200 to 1,500 boxes of packed fruit, and provide storage space for an accumulation of 6,000 boxes of loose fruit from the orchards, but no space for packed fruit.

COMMUNITY PACKING-HOUSE EQUIPMENT.

Where machinery was not used the usual equipment observed consisted of sorting tables, packing bins, packing stands, nailing presses, stamping devices and box trucks. Many of the houses were equipped with sizing machines, sorting belts, and gravity conveyors. In some of the houses sloping wooden slides were used as substitutes for gravity conveyors, or to supplement them, for carrying the fruit short distances. Of the 40 community houses investigated 21 used sizing machines, 12 used sorting belts, and 7 had no power machinery; 12 used gravity conveyors; 9 used wooden slides; and 19 handled the fruit entirely with trucks and by hand.

SIZING MACHINES.

Four different makes of sizing machines were observed in use, three of which sized the fruit by gravity and one by diameter. Twenty of the houses were equipped with the former type and one with the latter. Two other machines, which sized by diameter, were observed in houses not included in the investigation. Sizing by weight or gravity insures accuracy regardless of the shape of the specimens and results in a minimum amount of injury to the fruit.

Although not essential to good work the sizing machine appears to be an important part of the packing-house equipment, and its importance will become more evident as the production of fruit increases and the labor situation becomes more acute. Packers who put up unsized fruit were paid 5 cents per box, while those who packed machine-sized fruit received 4 cents per box, a reduction of 20 per cent in the labor cost of this operation. The cost of operating the machine, the interest on the investment, and the depreciation

absorb at least a portion of this difference, but no definite figures showing these items of expense are available.

Injury to the fruit.—Numerous examinations of machine-sized and hand-sized fruit were made to determine the amount of injury caused by the operation. Although machine sizing resulted in rather more injury to the fruit than handwork, this did not appear to be serious, and in no instance was the injury sufficient to discourage the use of machines. When the fruit was delivered from the sizing cup with considerable momentum and rolled nearly the full length of the sloping bins, bruises and stem punctures sometimes resulted, but the most serious cause of injury observed was that of allowing the bins to become full to overflowing, so that in certain types of machines the specimens discharged from the cups not only fell directly on the apples in the bin but rolled over into the adjacent bins. When the stem of the falling apple struck the cheek of one in the bin the result was usually a stem puncture. This condition was caused by inattention on the part of the workmen rather than by any defect in the machine, and should never be permitted to occur.

Test for accuracy.—To test the accuracy of the three makes of gravity machines specimens of the sized fruit in the several bins of each machine were weighed on postal scales and the weights recorded. From 40 to 50 apples in each bin of 10 machines in 7 houses were weighed. With few exceptions the variation in the size of the fruit in any given bin was not over an ounce, and in most of the bins one-half ounce covered the variation. The fruit in each bin was found to be sufficiently uniform in size for good box packing, and there was practically no difference in the accuracy of the work of the three types of gravity machines. A similar test was made of fruit sized by hand, and the results show that the work of professional packers, and of many of those with less experience, was fully as accurate as that of the machines; but, as a rule, the fruit sized by inexperienced packers was not so uniform as that sized by the machines. This was especially true of fruit packed at the orchards.

Details of machines.—In figure 7 are shown the floor lines for the proper clearance of several types of machines when set up with such accessories as seem to be necessary. These machines and their accessories are shown in the outline drawings in figures 3, 4, and 5. A number of machines are in use for sorting and sizing fruit, but those selected for illustration show the principal types now commonly used in the Northwest. They are well-known types and are readily available to those who wish to install them.

The machine shown in figure 3 sizes by gravity and is provided with a sorting belt, which is an endless web, power driven, and car-

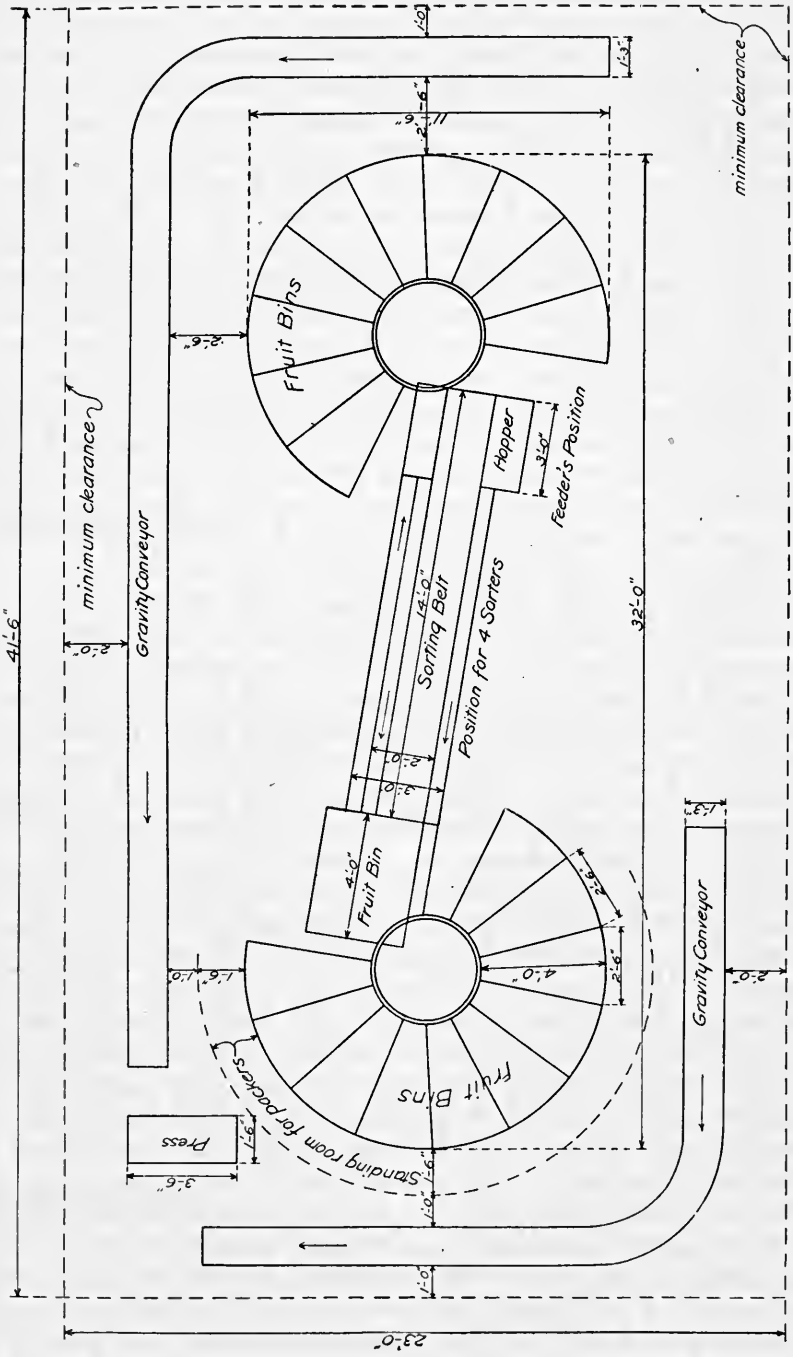

FIG. 3.—Type A sizing machine with gravity conveyor and other accessories, showing proper clearance.

ries the fruit from the hopper to the sorter, who grades and places it in the lines to the sizing device. This machine will size only two grades at one operation. The sizing is accomplished by an apparatus which controls a circle of 16 cups carried on the inner circle shown at each end of the sorting belt. An elevator receives the fruit from the narrow lines at each side of the sorting belt and delivers it to the cups so that the apple falls directly into a cup as it passes the end of the elevator. These cups are supported upon arms which are so balanced by an adjustable mechanical device that the fruit is dropped into the bins shown around the circle. Thus 10 sizes can be made with very reasonable accuracy.

The circle of cups revolves once in 6 seconds when run at the usual speed and would consequently drop from the two units 320 apples per minute into the bins, provided every cup carried an apple, but it is manifestly impossible for the sorters to keep the lines running full at all times. Observations made showed that the actual delivery was about one-half this number. This depends upon the quality of the apples running at any time on the sorting belt.

The regular grades packed in the Northwest are extra fancy, fancy, and C grade. As the machine has only two sizing devices, one grade must always be taken off or run to the bin, which is shown at one end of the belt. In some houses this grade was taken off in boxes and in others it ran in the narrow line to a special bin. This fruit was either sized by hand or later run over the machine for sizing. Figure 3 shows a convenient placing of gravity conveyors by which the packed fruit is all brought to one press. The floor space with the clearance indicated is 23 feet by 41 feet 6 inches.

The machine shown in figure 4 has a different arrangement of the parts. The fruit all moves in one direction from the feeder's position to the fruit bins. It handles three grades of fruit, sizing and delivering each grade into a separate set of bins. For instance, the grades on the two outer lines are placed in the first nine bins on each side, and that on the center line is placed in the last four bins on each side. The sizing is by gravity, but is accomplished by using a counterpoise so placed in a receptacle that it permits the fruit to trip by its own weight and drop into the proper bin. In each of the several counterpoise receptacles is placed an apple selected to give the size desired for that particular bin. These can be changed readily to readjust the sizing without stopping the machine.

The fruit passes down the sorting belt, workmen remove the culls, grade the fruit, and place each grade in its proper line. From the three narrow spaces extending down the center of the belt the apples go over a feeding device and fall directly into the canvas pockets carried on an endless web. As this web passes along, each fruit is dropped into the proper bin, with very reasonable accuracy. The

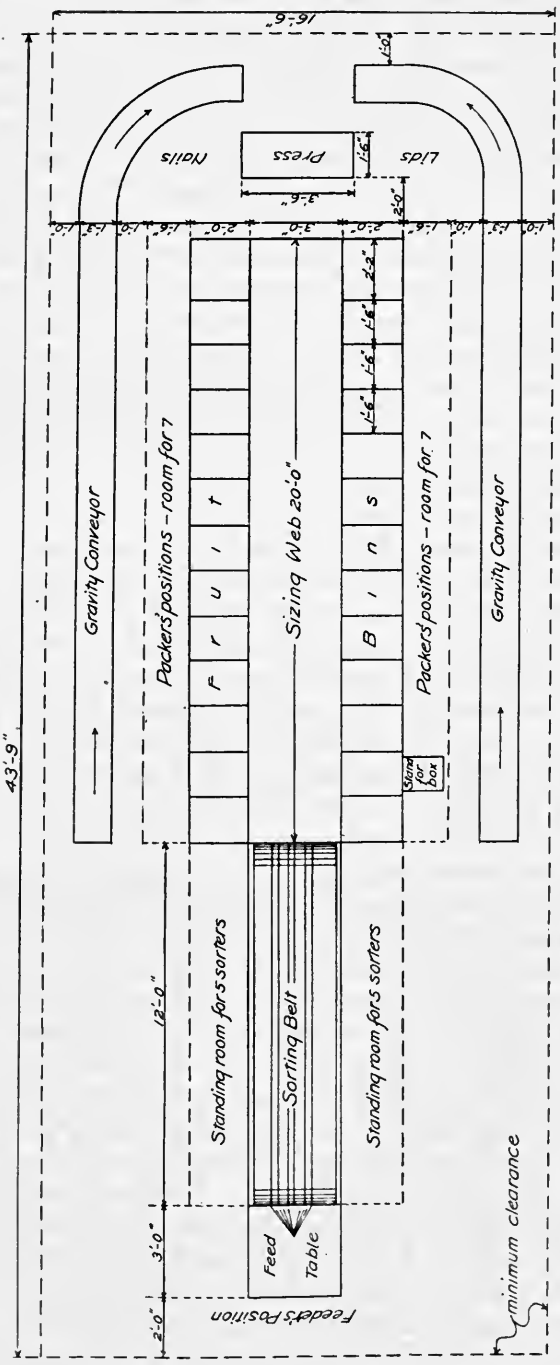

FIG. 4.—Type B sizing machine with gravity conveyor and other accessories, showing the proper clearance.

web at usual speed makes an entire revolution in approximately 17 seconds, and would deliver 360 apples to the bins per minute if each cup carried an apple. However, it is evident that in practice the lines of cups can not run full, as the several grades will always vary in amount of fruit, dependent upon the quality of the crop. According to a number of observations made, the sizing web carried an average of 53.1 per cent of its capacity. This is thought to be a fair statement of the practical results obtained under good conditions.

The floor space occupied with the accessories shown (fig. 4) and allowing proper clearance is 16 feet 6 inches by 43 feet 9 inches. The delivery of the packed fruit to the lidder's press by the gravity conveyors is very convenient. The position indicated for the press requires that a gravity conveyor run the nailed boxes to the point where they are assembled.

The machine shown in figure 5 also sizes by gravity, but is constructed on an entirely different principle from that of the counterpoise machines. The apples are tossed or thrown from cups, actuated by a cam motion, and the bin into which they fall is determined by the initial velocity and the weight of the apple. The velocity or force of the throw is obtained by the use of one or more torsion springs set at the tension desired. The proper tension is determined by the use of trial balls before the machine is put into operation on the fruit. The machine in outline closely resembles that in figure 4, and the fruit moves in a direct line to the completion of the operation. The springs are set to throw one grade to a certain number of bins and the next grade to bins beyond, so that the largest fruit falls where the smallest fruit of the previous grade stops; thus it always follows in practice that some overlapping occurs, but as this is at the extremes of sizes, only slight mixing results.

The fruit is sorted and graded on an endless belt as is done with those in figures 3 and 4, and each apple is put into the proper grade line for delivery to the tossing cups. A feeding device drops the apples into the cups with great accuracy and the operation goes on with precision. When three or four lines are running, several fruits may be in the air at the same instant. The apples fall into canvas folds or divisions held in place by springs, to lighten the impact, and they then roll into the bins. Tests of the sized fruit showed substantial accuracy. Timing the machine in operation showed that each cup made 90 throws per minute; thus 2 cups could handle 180 apples, and 4 cups 360 apples per minute; but, as with the other machines described, the lines never run full. About 50 per cent of actual capacity was observed in practice. With the accessories thought necessary, including clearances, the space occupied, as shown in figure 7, is 17 feet 6 inches by 41 feet.

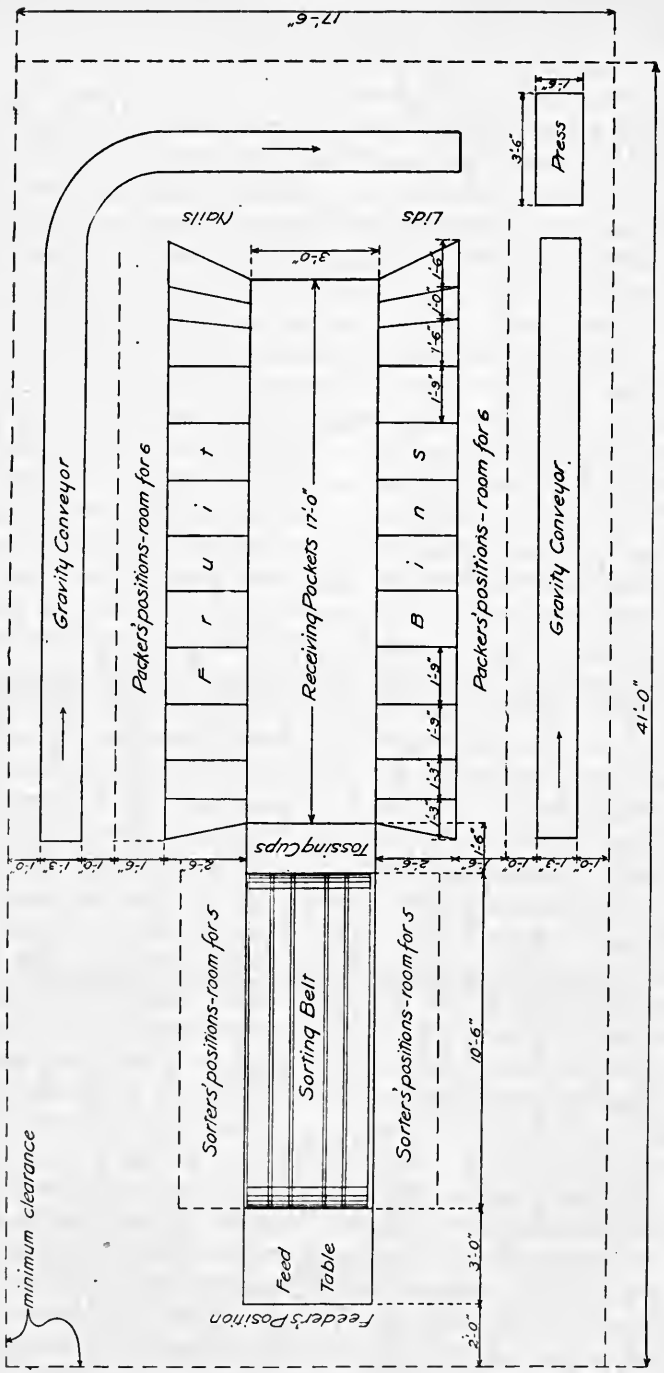

FIG. 5.—Type C sizing machine with gravity conveyor and other accessories, showing the proper clearance.

THE SORTING BELT.

The machine shown in figure 6 is a sorting belt with bins along the sides and at one end. It does not size the fruit, but carries it in front of the sorters to be graded and distributed to the various bins. Many of these sorting belts were observed, and while no two of them were equipped exactly alike, they are fundamentally the same. The apparatus consists of a wooden frame, made in varying lengths to suit the needs of the user, which carries an endless cloth belt, power driven over drums at each end. The height is about 42 inches and the usual width is 26 inches over the frame. The drums were usually about 15 inches in diameter and the belt about 22 inches wide. This belt runs on a smooth surface with 2-inch side strips in its upper course and either free or on a similar surface below. The lower section of the belt may be used for conveying the cull fruit to a receptacle at the head of the frame. A short feed table sloping to the belt is provided at the head of the machine. The principle of moving the fruit in front of the sorters as shown in this apparatus is used in all the sizing machines discussed above. As developed in some of the houses, it is an excellent device for convenience of sorting and grading. By means of deflectors the graded fruit may be placed in bins with certainty and with only slight mechanical injuries.

The most efficient arrangement of the sorting belt observed is shown in figure 6 and may be described briefly as follows: The length of the belt is 22 feet, and of the feed table 3 feet. The bins occupy a space 3 feet wide on each side of the framework, and a like dimension across the lower end, thus furnishing very large bin capacity. The sorters' positions are shown at the head of the belt and in the three V-shaped spaces cut into the bins, giving actual space for 9 sorters if needed. This number would be necessary only with very poor fruit.

Above the belt, at each side, and supported from cross rods attached to the frame, is a line of $\frac{3}{8}$-inch gas pipe, which is adjustable on the support, but is usually placed about 4 inches from the margin of the belt, so as to give a narrow line on each side in which graded fruit is placed by the sorters. The belt carries the graded fruit to the bins. In the side strips are set, at the proper points, hinged gates, which may be opened inward to touch the pipe lines, and thus deflect the moving fruit into the bins. This admits of convenient manipulations, as indicated below. The first sorters at the head of the belt take up the two lightest grades, usually the Fancy and the C grades, and place them in the side lines, and the deflectors turn them into the nearest bins. Ordinarily these grades would occupy

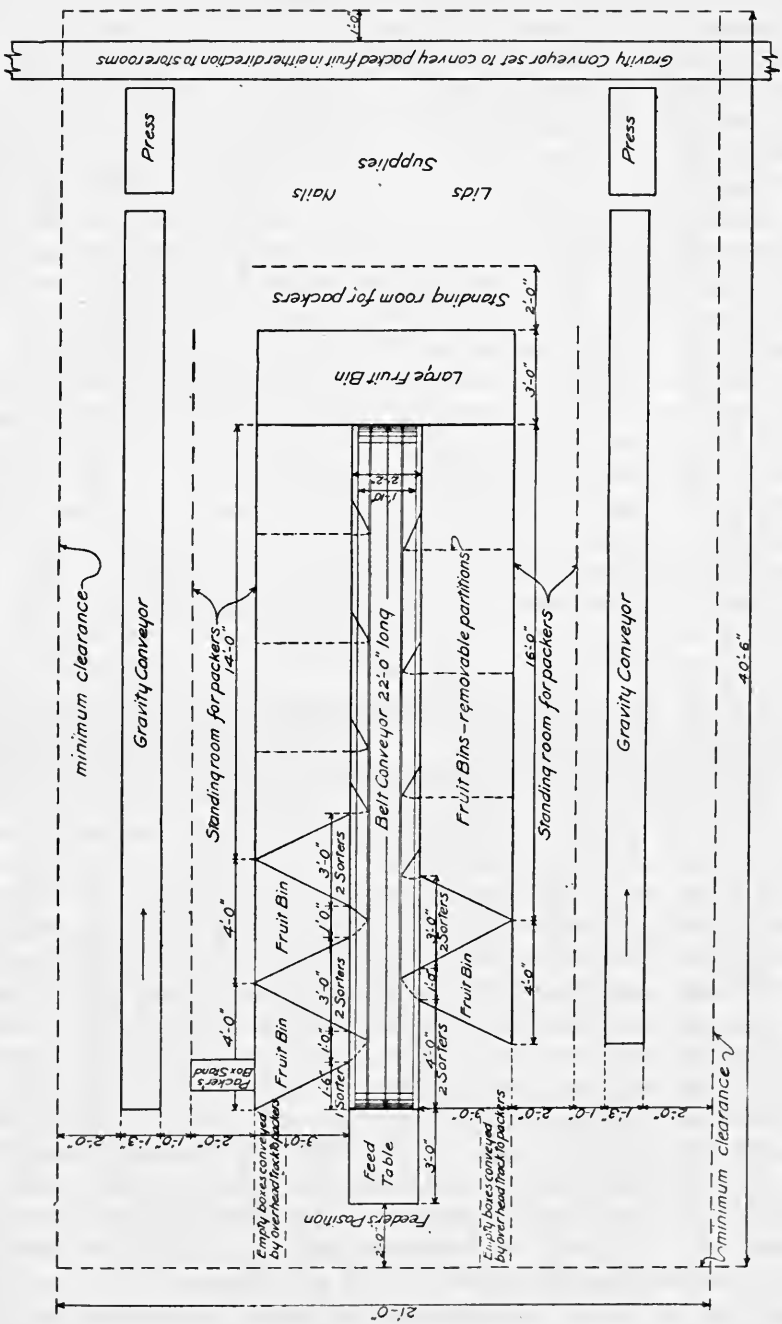

Fig. 6.—Sorting belt with fruit bins, gravity conveyor, and other accessories, showing the proper clearance.

two bins on each side of the belt. The heaviest grade, usually Extra Fancy, is not picked up, but is allowed to pass down the center of the belt after due inspection by rolling with a light sweep of the hand. The culls are removed and dropped down a small chute attached to the frame of the machine to the lower section of the belt which carries them to the head of the frame, where they are discharged by a deflector into a receptacle.

When the fruit is running heavily to one grade often 65 to 75 per cent of it is not picked up by the sorters. The last man acts as a watcher to catch any errors in grade as the fruit passes him. If not deflected to the side lines, the fruit in the center line continues down the belt and is discharged into the bin at the end of the machine. To secure convenient distribution to the side bins the lines of $\frac{3}{8}$-inch pipe over the lower part of the belt can be disconnected readily, and a deflector can be used to turn the fruit into any of the bins on either side of the belt. The dotted lines across the side bins below the last sorters' positions represent movable divisions. (See fig. 6.) These are convenient when it is found necessary to run more than one grade down to this part of the machine. The bins slope away from the belt and are 36 inches high at the outer margin. They are lined with canvas and padded at the lower side to prevent bruising the fruit. This outfit, with all accessories, occupies a space 21 feet by 40 feet 6 inches. (See clearance lines for type D in fig. 7.)

CONVEYORS.

The fruit should be conveyed from point to point in the house with the least possible hand work. Roller-gravity conveyors were used for this purpose in 12 of the houses visited, and they effected a considerable saving in labor. (See fig. 8.) In some of these houses the fruit traveled on gravity conveyors practically the entire distance from the orchard wagon or truck at the receiving door on one side to the storeroom or car on the other side. The boxes of loose fruit from the orchard were placed directly on a section of the conveyor which extended through the receiving door to the load and were carried by gravity to the stacking space on the floor and from there to the feed end of the machine as needed. In like manner the packed boxes were conveyed from the packers to the nailer and from the latter to the assembling floor or storage room. Also, in one instance at least, a gravity conveyor was used to run the fruit from the storage room into the cars. The conveyors are in sections and may be lengthened or shortened as desired, and curved sections are used to direct the fruit in any desired course. Castor rollers may be used on the sections to render them more readily movable.

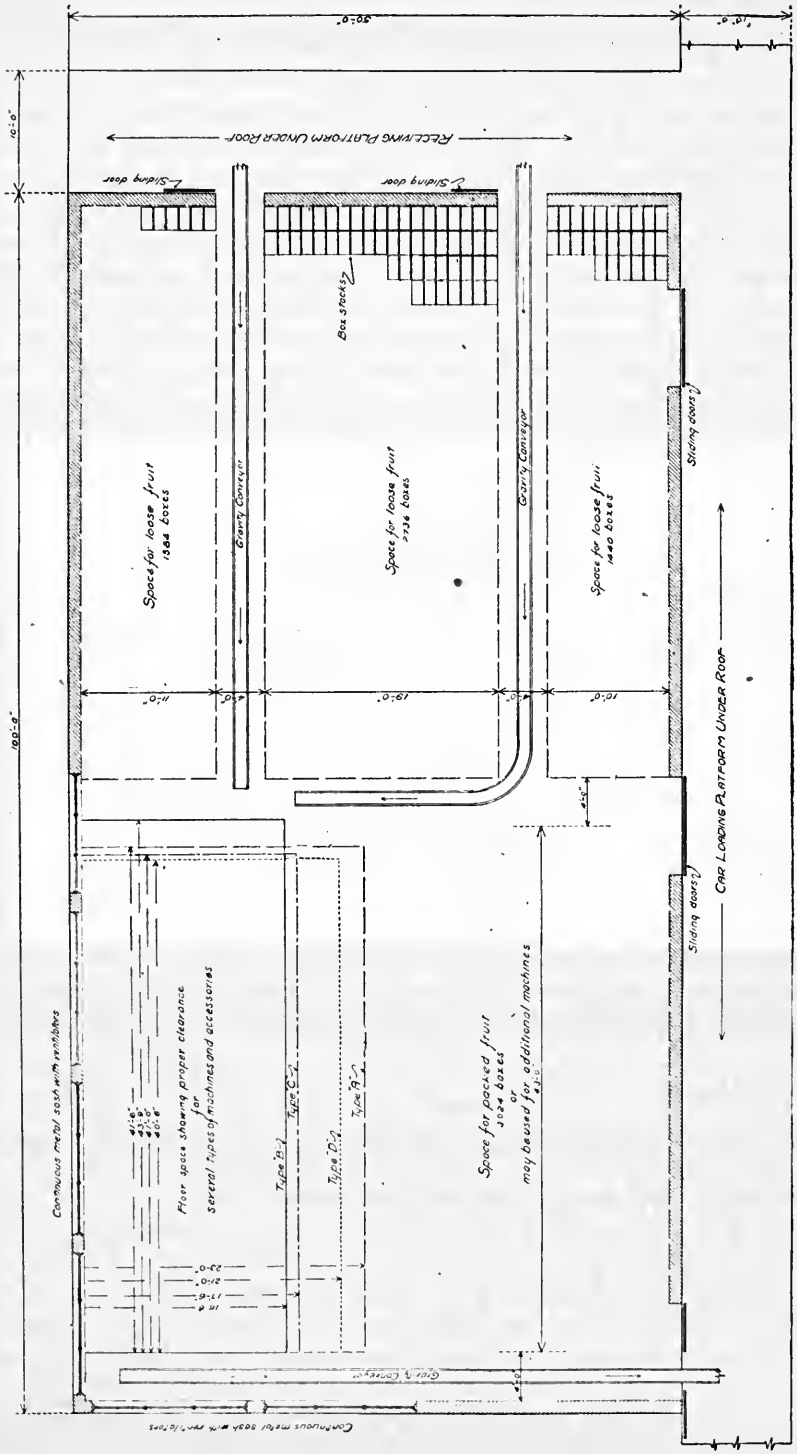

Fig. 7.—Floor plan of packing house, showing loose-fruit space with gravity conveyors and space for the operating equipment shown in figures 3, 4, 5, and 6.

SLIDES AND RACKS.

In nine of the houses without gravity conveyors sloping wooden slides were used to convey the fruit short distances, particularly from the packer to the nailer. Some of the houses used both slides and conveyors in order to obviate the expense of equipping fully with the latter. The slides are inexpensive and are very convenient for handling the packed boxes from the packer to the nailer and from the latter to the assembler or trucker near by. When gravity conveyors are not used the slide is considered an important part of the equipment. It not only facilitates the handling of the fruit, but it serves as a table to receive the packed boxes from the packer and dispenses with the objectionable practice of stacking them one on

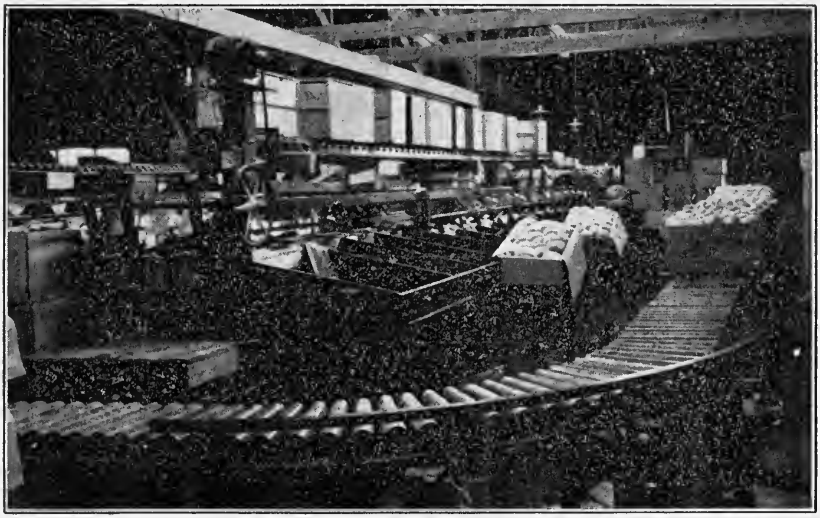

FIG. 8.—A packing unit, showing a sizing machine, gravity conveyor, and overhead roller track for empty boxes.

another before they are lidded. In some of the houses the boxes were stacked from three to four high and trucked to the lidding press. This practice not only requires more hand labor, but tends to injure the fruit.

To supply the packers with empty boxes overhead racks were used in some of the houses. They were suspended above the packing bins or over the sizing machines. (See fig. 8.) If the racks are fitted with rollers similar to those of a gravity conveyor, the boxes may be placed on one end and are easily pushed to any position desired. Also racks for paper liners and wrappers are placed in convenient reach of the packers. Conveniences of this kind add greatly to the efficiency of a packing force.

PACKING-HOUSE ORGANIZATION AND PERSONNEL.

The work of receiving and packing fruit in the Northwest involves so many details that a full and minute consideration of them is not possible in this preliminary report. However, some discussion of the subject is warranted by the observations made. In the small houses it is not possible definitely to fix the status of each employee so that his duties are differentiated from those of all others. Therefore, in order to suggest somewhat definitely the force necessary to receive, pack, and store the output of a house, the unit of floor shown in figure 7, the capacity of which is 30,000 to 50,000 boxes, is taken as the basis of the discussion.

There is at present a considerable diversity in house organization and in some cases a decided loss in efficiency through lack of experienced foremen. These are defects incident to any business which grows to large proportions quickly. The suggestions offered here are a composite of the best details observed and may have value in remedying some of the defects.

It may be taken for granted that a unit, packing 30,000 to 50,000 boxes, should have a general manager who is the business head, both in the packing house and the office, but who does not personally handle the details of the packing operations. The receiving clerk and the checker who records the packed fruit as it goes to the storeroom are, or should be, a part of the office force. While a disposition to be mutually helpful must be maintained between all employees on the packing-house floor, these clerks should report only to the office. Discrepancies and mistakes will surely occur and should be promptly brought to the attention of the business head of the house.

The foreman of the packing house is, or should be, the chief assistant of the manager. Upon him rests the direct responsibility for the successful operation and control of the labor. He must be a man of many qualifications, with sufficient mechanical skill to handle the machines, tact and ability to control the help, and orderly habits to prevent confusion and waste of effort, and he should be an expert grader and packer. This man may be an employee or a contract foreman, but the requirements are the same in either case. All the employees, except the receiving clerk and the checker, should be responsible solely to him.

Instances were observed where there was no real foreman but several petty bosses, and others where the foreman was the checker at the receiving doors or had other duties, and these conditions tended to confusion and loss of efficiency. In still other instances the foreman acted as inspector under the State grade law. This appeared to be objectionable, for the reason that it is not a correct principle to

permit him to be the legal agent to pass upon his own acts. Certainly the foreman is always in one sense an inspector, because he controls every operation of the packing floor, but when he also acts as the agent of the law it appears to unite quite incompatible functions and is inimical to good order and harmony. The inspector should never have any business relations with the work upon which he passes.

The working force of the packing floor consists mostly of help that requires no special training. Certainly it is well to employ persons who have worked in a packing house before, but the lack of experience is not a bar to their usefulness. A competent foreman will very soon break them in. This does not apply to the packers and lidders. Under the old usages of hand sizing a packer could not do good, rapid work until he had had much experience. The expert hand sizers and packers were usually persons who followed packing the year round and migrated up and down the coast States as the various crops offered a chance for their special work. They were rarely local residents. It is also true that the lidder needs a large amount of practice to become a rapid workman. The expert lidders were also migrants who followed and worked with the expert packers. Both of these expert types are a development of the old methods, now giving way to the changes in methods incident to the greatly increased production.

The training of packers on machine-sized fruit has now become a comparatively simple matter. A competent foreman can assemble his crew and run practice work for a couple of weeks before the harvest opens, and is thus enabled to select packers who do the work well. Many persons, men and women, who had had no previous experience were found to be packing acceptably. It follows as a matter of course that these local people will become more expert from year to year. The lidder can not be trained so easily, but box-making offers an excellent opportunity to train men for this work, as it begins weeks in advance of the harvest. The conditions observed in the Northwest render the training of local help one of the most vital questions.

The number of persons needed for a crew is determined partly by the amount of fruit to be packed and partly by the equipment used. For a unit with one sizing machine running on average fruit, the force should consist of a foreman, a receiving clerk, one man to deliver the fruit to the machine and to remove boxes and culls, one man to feed or pour the apples, four or five sorters, six packers (local trained), one man to wait on packers, one lidder, one checker, and one assembler who may also do some trucking. Additional labor must be provided for labeling and car loading. This force should average 750 boxes of packed fruit per day. If, as is suggested under

the discussion of the house layout, a second sizing machine be added, only the machine force would have to be duplicated, and the output of the house could be doubled.

If the sorting belt, shown in figure 6, is used instead of sizing machines, the force for one unit would be increased by about four packers, the other help remaining practically the same. It was found that the local packers working on unsized fruit rarely packed more than 75 boxes per day, while the itinerant experts packed 100 to 125 boxes.

Where the small, individual sorting tables were used, one sorter was usually required to each packer. The serving of fruit to all these individual tables and the removing of boxes and culls added to the labor. This arrangement makes each pair of sorters and packers in effect a unit by itself, and while it facilitates the working up of small lots, it does not yield readily to correct principles of organizing a large force. In one house of this kind 12 sorters served 20 packers, but the daily output averaged only 1,300 boxes, while in another house, with 23 sorters and the same number of packers, the average was 2,100 boxes. The condition of the fruit and the speed of the packers will affect the number of sorters required.

A SUGGESTED FLOOR UNIT.

The apparent tendency is toward community packing houses, but there will remain always the ranch packing house, where individuals, who prefer to do so, will pack their own fruit. Even though they may be mere temporary structures or tents, the principles involved as to correct dimensions and the conveniences necessary to secure the orderly progress of the fruit through the house are essentially the same as for larger and more permanent structures. It is not the purpose of this report to give details of exact size, dimensions, and equipment for packing houses, but rather to discuss certain ideas which have a strong bearing upon the convenience of arrangement and the economical handling of the fruit.

Location of building.—The first consideration is the placing of the building. For a grower's house, the location is at the ranch regardless of shipping facilities. Even here it is important that convenient access for delivering the loose fruit and removing the packed fruit be provided. For instance, the boxes of loose fruit should enter at one end or side and the packed boxes should be loaded out at the other, and the floor of the house should be high enough to permit of convenient loading and unloading. If the floor is below the bed of the vehicle, a bench across the door at the proper height to receive the boxes is a convenience in those houses where gravity conveyors are not used.

For the community packing house or the commercial operator, the location should be at a railroad siding. Only some very unusual obstacle should prevent the selection of such a location. Where the distance is not too great, probably no advantage in locating the packing house off the railroad would compensate for the cost and inconvenience of the extra loading and unloading involved in hauling the loose fruit to the packing house and the packed fruit to the railroad. To a house located at Pateros, Wash., some of the fruit was being hauled 30 miles apparently without serious difficulty. It was observed, however, that some of the apples hauled long distances showed a browning of the skin in spots, due to rubbing against the sides of the boxes. This was especially true of the Yellow Newtown variety. A 5-month cold-storage test on 22 boxes of apples hauled 12 miles showed that the fruit packed in the orchard before hauling kept slightly better and had a somewhat better appearance than that which was hauled loose in boxes and packed at the railroad. Conclusions should not be drawn from so small a test, but sufficient evidence was found to indicate that there is a limit to the distance which apples can be hauled with safety before packing. Lining the orchard boxes with paper would tend to prevent injury.

The lay of the ground is important for convenience in receiving and loading out the fruit. The ideal location is on a slope which runs down to the railway tracks at such an angle as to permit of constructing the packing floor at the wagon-road level on the upper side, and the floor of a basement story, for storage, on a level with the car-loading platform and continuous with it. Examples of this arrangement of floors were observed at Wenatchee, Okanogan, and Hood River, but many houses have been built without regard to these details. By locating on such a site the fruit may be moved from the receiving platform through the packing house into the storeroom, and from there into the cars entirely by gravity conveyors. The packing floor should be a part of the receiving floor. In some very important houses the fruit was elevated to a second and even a third story to reach the packing floor. The consideration that less land is required to furnish the floor space when several stories are used has little significance compared to the loss of effort and the inconvenience suffered.

Protection of the fruit.—The choice of material used will be governed, necessarily, by the character of the house and the money outlay decided upon. For the receiving and packing room it is not usually necessary to provide protection against serious drops in temperature. Yet a cold spell early in November of 1916 caught much fruit unpacked and caused considerable damage. Therefore, the ordinary packing room should at least be so well constructed that it can be closed tightly. In a tight room with no access of air slight freezing

temperatures may not hurt the fruit materially, especially if it is not handled until the temperature has risen. In the large receiving rooms, where there may be at times 10,000 or more boxes of loose fruit without protection against freezing, a simple hot-water heater with straight runs of pipes along the walls could be made to give ample protection and the installation of the heater would be much less expensive than insulating the walls. It is also important to keep the fruit cool so as to arrest the ripening processes and prevent deterioration.

It is absolutely necessary to provide against freezing where fruit is to be held into the winter; therefore a frost-proof storeroom should be provided for all houses which handle more fruit than can be promptly loaded out and sent to market. As a primary statement it may safely be said that the best manner of insuring a storeroom against low temperatures is the use of cork insulation on the entire surface of the room. It is well known that good wood or brick construction can be insulated just as effectively as hollow-tile or concrete construction; that is, given a good wall construction, the nature of the material is not of vital importance and should be determined by local conditions. The most convenient plan is to build the storeroom beneath the packing room, but if conditions render this impracticable it should be placed between the packing room and the railroad track. These rooms should be a part of the same structure, with only a dividing wall, furnished with convenient doors for the transfer of the packed fruit. The floor should be on a level with the car-loading platform and furnished with doors at convenient intervals for placing cars. If this room is to be artificially refrigerated all the doors should be of special construction, such as are used in cold-storage houses, and it is better to provide artificial light and have the walls without windows.

Lighting the packing floor.—Top lighting can be secured readily by constructing the regular saw-tooth roof commonly used on machine shops, or a penthouse story over the center of the span. If the penthouse story is roofed with skylight glass, and the inside walls finished smooth and painted white, very good light can be obtained, but the saw-tooth system is preferable where extremely heavy snows do not make it impracticable. Windows in the walls of the building where the space is occupied by the stacks of loose fruit should be above the height to which the boxes are piled. By placing the operating space at one end and one side of the building, floor space is economized, and ample lighting is secured through large windows in the side and end walls. (See fig. 7.) For use at nights and on cloudy days electric lighting should be provided. It is especially important to have the sorting table well lighted.

This may be accomplished by suspending above the table a long reflector in the shape of an inverted trough fitted with electric-light bulbs.

The floor space.—The arrangement of the packing-floor space of the house is of vital importance. The fundamental principle involved is that the fruit should proceed by regular stages from the point where it is received through the packing operations and then to the storeroom or to the car with the least possible trucking or handling, and certainly without reversing its course or crossing the floor through the operating space. To secure economical use of the floor space the roof of the house should be carried upon trusses of not less than 50-foot span, thus giving a large, clear floor space.

In figure 7 is submitted a sketch showing a floor unit, 50 by 100 feet, with a suggested arrangement for the operations. On this sketch the operating floor is located adjacent to large windows. This floor space with one efficient sizing machine is sufficient to handle 30,000 boxes of packed fruit during the season, and with two machines the output of the house can be doubled. While this floor plan has been designed for the installation of either sizing machines or sorting belts, it can be used with equal facility for table work without any power devices whatever. It is apparent that the large space adjacent to the machine position, if not used for fruit storage, may be used for the installation of an additional machine or other apparatus for packing. Any properly constructed house where as much as 30,000 boxes of packed apples are to be handled should be provided with storage space for packed fruit in a separate room.

The mechanical equipment of a packing house does not involve intricate problems. It is, in fact, comparatively simple. Yet the proper placing of tables for handwork, or of sizing machines, in connection with their necessary accessories is vital to the orderly progress, speed, and efficiency of the work. Therefore, the dimensions of a floor unit, the location of the loose-fruit storage space, and the lines of movement for the fruit before and after packing, are details which require consideration. The proposed dimensions given in figure 7 have a certain relation to the conditions observed. For instance, a house packing about 30,000 boxes has an accumulation of from 4,000 to 6,000 boxes of loose fruit during the height of the season. During the investigations it was found that houses packing 50,000 or more boxes would often have 6,000 to 8,000 boxes of loose fruit on hand, and in very large houses there was at times an accumulation of 20,000 boxes or more of loose fruit. In some instances the houses and the receiving platforms were filled to capacity and fruit was stacked on the ground outside of the buildings or in tents which afforded but little protection from frost or from high tem-

peratures. Also much picked fruit stood in the orchards for days waiting for the congestion at the packing house to be relieved. Hence, the lack of provision for adequate storage and protection for the unpacked fruit is one of the points most open to criticism. On the other hand, a large accumulation of unpacked fruit should be avoided as much as possible, unless it can be kept at a temperature that will prevent undue ripening. When allowed to become overripe for shipment it can not be expected to arrive in the market in good condition and is certainly not suitable for long-period storage. When practicable, it is a good plan to leave the fruit which is picked during the afternoon in the orchard over one night, and to haul it early the next morning, thus delivering it to the packing-house floor in a cool condition. Too much emphasis can not be placed on the importance of keeping the fruit cool from the time it is picked until it reaches the market.

In the floor unit proposed in figure 7 the receiving platform is 10 feet wide and 50 feet long under roof, which gives ample space for unloading and even for holding fruit temporarily until it can be put inside. In some cases the platforms observed were not covered and were stacked full of fruit, which stood for days in the open weather. With a projection roof over the platform and a drop curtain of duck, it becomes a closed space quite well sheltered from ordinary inclement weather and is much superior to a tent.

In designing the floor space consideration has been given to the importance of allowing as little waste space as is compatible with free access to the stacks of fruit, hence the receiving doors are but 4 feet wide, corresponding with the alleys which extend through to the operating floor. The sketch shows gravity conveyors in each aisle. As these are mounted on supports fitted with castors, it is an easy matter to run them out to the vehicles and deliver the fruit to practically any point on the aisle desired. With such an arrangement one man less is needed to place the fruit in the stacks and the speed is accelerated. The conveyor which extends from the receiving door to a point near the feeder's position at the sorting tables may be disjointed at any point in the aisle so that the sections at the receiving door may be run forward to the vehicles and also set at an angle to deliver into the stack space without moving the entire track. When delivering fruit to the operating space, it is only necessary to bring the free ends into contact to have a continuous track. With some ingenuity in arranging this device, there need be very little trucking.

It is important to have long stack fronts as indicated in the plan. With this arrangement, varieties and crops may be segregated, and, at the same time, they are easy of access when the fruit is wanted. This stack space will accommodate approximately 5,760 boxes. The

space adjacent to the machine position is indicated as storage for 3,024 boxes. This could be used temporarily for packed fruit where other storage is not provided, or for boxes of loose fruit, or it may be used for additional packing equipment. It is contemplated that basement or other storage space for packed fruit will be provided.

Provision is indicated on the plan for a gravity conveyor to remove the packed fruit to the storeroom or to cars as desired. By the use of 90-degree curves the boxes can be delivered direct into the cars at any position along the platform. The car platform shown in the plan is 10 feet wide and should always be under roof, as it offers convenient space for the temporary storage of one or more carloads of fruit. The extension of this roofed platform beyond the building lines adds to the facilities for handling incoming and outgoing freight. This necessarily presumes that additional track frontage for such an extension is available.

SOME OF THE DETAILS OF OPERATION.

Hauling the loose fruit.—Most of the hauling is done by the growers, but in some localities community hauling is practiced. In such cases the management of the house usually lets the contract for the hauling and charges the grower with the exact cost. Both wagons and motor trucks are employed for this purpose. With few exceptions, neither the wagons nor the trucks were fitted with special bodies or racks for hauling apples and this detail apparently has not received the attention it deserves. The best arrangement observed was the slatted-stake body, with sides in sections, which may be removed easily for convenience in loading and unloading. The dimensions were such as to permit a low, compact load of maximum weight.

Receiving and checking.—In most of the houses the fruit is unloaded on the receiving platform, stacked five boxes high, checked by the receiving clerk, and trucked to the loose-fruit storage space in the building. Where gravity conveyors are used in conjunction with vehicle bodies that have removable sides, the driver places the boxes on the end of the conveyor, which delivers them to any desired point in the house. This obviates a large part of the trucking and facilitates the unloading. The records made by the receiving clerk consist of the date, the grower's name, the variety of apples, the number of boxes, and the name of the driver, who is given a duplicate of the receiving slip. The fruit goes into the stacks with a card attached giving the necessary data for identification and it retains its identity until it is nailed up and checked. As the boxes pass from the nailing press to the assembling floor or the storeroom the checker records in connection wtih the grower's name the grade and size of the fruit in each box. The fruit then goes into the house

pools and loses its identity. This applies more particularly to community houses operated on the cooperative plan. In houses which pack for a community of growers under individual contract each grower's fruit must retain its identity in the storerooms, as pools are not handled by contract houses.

A notable exception to this system was observed in the house of the Entiat Growers' League at Entiat, Wash. Here was followed a system of sampling by weight and determining from the sample the grade and size credits to which the grower was entitled. The loads of fruit from the orchards were weighed at the receiving door and both the gross and net weights recorded in addition to the usual data. As the fruit was being unloaded a sample sufficient to make 5 per cent of the net weight of the load was taken. The remainder of the load went into the loose-fruit storage space with other fruit of the same variety regardless of ownership. In a space set aside for the purpose near the door the sample was graded and sized by an experienced man, and the weight of the fruit in each group of sizes in each grade was used as the basis for determining the credits due the grower. After having served its purpose, the sample went into the stacks to be graded, sized, and packed with other fruit. The results of the test were recorded on the following form:

SAMPLE TEST.

THE ENTIAT FRUIT GROWERS LEAGUE.

No. ..... Entiat, Wash., ..., 191..

Grower.....

Variety.....

Loose Fruit Receipt No.	FRUIT			
	No. of Picking Boxes	Weight Boxes Inc.	Weight of Boxes	Net Weight

SAMPLE

Per cent.	No. of Boxes	Gross Weight	Weight of Boxes	Net Weight

THE ENTIAT FRUIT GROWERS LEAGUE.

Test Clerk.

Grades	Sizes	Weight
Extra Fancy	36–125	
	138–175	
Fancy	36–125	
	138–200	
"C"	36–163	
	175–225	
Export	150–200	
	216–250	
Culls		
Total		

By this method the fruit goes at once into the house pool and the work of keeping individual crop records during the packing operations is eliminated. Any variety may be fed to the machines con-

tinuously until the supply in the house is exhausted, thus avoiding the loss of time involved in clearing the bins after each small lot is run, as must be done under the other method.

Handling the culls and empty boxes.—The efficient handling of the culls, or unmerchantable fruit, is one of the unsolved problems in most of the houses visited; in fact, only one of these houses had a really convenient arrangement for delivering the culls at once to a point outside the packing room where they could be disposed of without interfering with the regular operations of the packing force. In many instances the culls were placed in fruit boxes at the sorters' benches, and from there trucked across the packing floor and even through the congested operating space to the point of final disposal. This practice is certainly faulty. Devices should be arranged whereby the sorter may drop the cull fruit into a chute leading to a conveyor which would deliver it to bins or other receptacles without further attention from the workmen on the packing floor. Where two or more machines are operated, or where long lines of sorting tables are used, a cross conveyor beneath the floor could be arranged to catch and handle all the culls readily. There appeared to be more needless waste of effort in handling the cull fruit than in any other one operation in the packing house.

Much confusion and loss of effort was observed in the disposal or removal of boxes emptied by the feeders in serving the fruit to the sorters. This operation is generally associated with the supplying of boxes to the packers. With few exceptions, the loose fruit from the orchards is delivered to the house in clean, sound boxes to be used for packing. It is estimated that about 70 per cent of the boxes containing loose fruit will be needed to hold the packed fruit. Hence, a certain percentage of old or inferior boxes may be kept in constant use, but each load delivered must contain the required number of bright, sound boxes for packing the fruit. The workman who empties the fruit on the sorting tables selects the boxes suitable for the packers and starts them on their course, while those unfit for this purpose are sent out to the orchard again. In most cases they are piled on the floor at the sorters' tables and then trucked to the packers' stands or to the point where they are to be loaded for returning to the orchards.

In a few instances, where the best modern mechanical appliances are installed, overhead conveyors for carrying the boxes to the packers were used and this appears to offer the best solution to this detail. (See fig. 8.) The workman who empties the fruit sorts the boxes and puts those desired for the packed fruit on the conveyor, which runs at the proper height immediately above the packers' bins. This puts them out of the way of the floor operations and in convenient reach

of the packers. In none of the houses, however, was there a well-devised plan for delivering the remaining empty boxes to a convenient point for sending out again to the orchards. In the further development of the overhead-conveyor idea, it appears that this device might be extended beyond the bins so that the boxes to be returned to the orchards could be delivered at some convenient point for loading. If this were done, the workman who places the boxes on the conveyor would sort them as before, and place the new boxes intended for the packers in an upright position, and the others on the side, so that the workmen could distinguish them easily.

Loading and bracing.—A carload of apples shipped from the Northwest commonly consists of 630 boxes, placed seven wide across

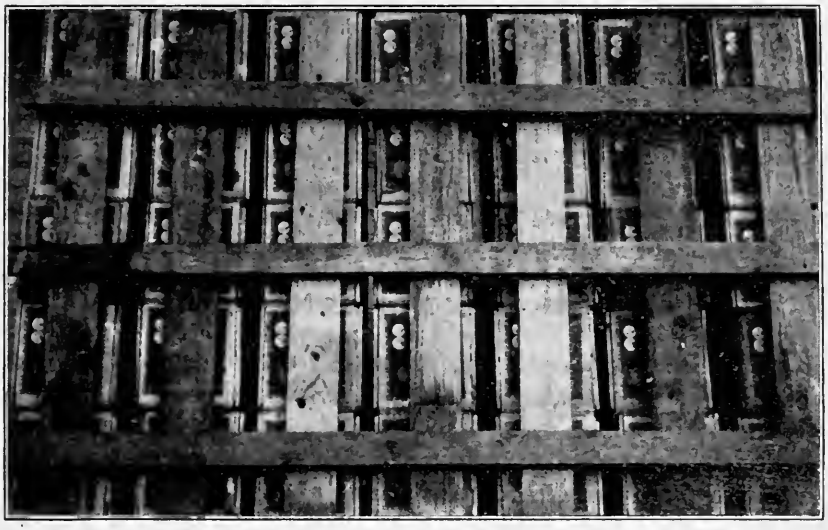

FIG. 9.—Frame in position for bracing a carload of apples.

the car and nine end to end lengthwise of the car on each side of the door space, and five high. The boxes are placed side down in vertical stacks and are equally spaced across the car. (See fig. 9.) In some instances, however, the boxes in the second and succeeding layers were placed over the spaces between the boxes in the next layer below. Under this method the circulation of air is obstructed and if the cars are handled roughly in transit some of the boxes are likely to drop down from one layer into the spaces of the next. This condition has been observed in cars inspected at destination.

Lath strips are nailed across the ends of the boxes in the third and top layers and also are sometimes placed on the floor of the car under the boxes without nailing. If the nailing of these laths is carelessly done, so that the nails fail to catch in the end piece of the box, a

shifting of the top layer and a consequent injury to the fruit is likely to occur.

Loading as described above leaves the space across the car between the doors vacant to be occupied by bracing timbers. The most approved style of bracing observed was as follows: Frames or "gates" are made with three 2 by 4 inch crosspieces 8 feet long and seven 2 by 4 or 1 by 6 inch upright pieces spaced to meet the ends of the boxes. (See fig. 9.) One of these frames is placed against the ends of the boxes on each side of the door, the 2 by 4 inch pieces running across the car and the seven upright pieces fitting against and in line with the seven rows of boxes. They are held in place by twelve 2 by 4 inch cross braces, placed four in a row immediately above each crosspiece in the frame. The braces are cut somewhat longer than the distance between the frames and are driven into place in order to take up the slack between the ends of the boxes.

This method of bracing was not followed in detail by all shippers, but it was generally considered to be the most satisfactory. In some instances only four upright pieces in the frames and a correspondingly smaller number of brace pieces were used. This did not appear to be sufficient to render the load entirely secure when the cars were roughly handled in switching.

THE OPERATIONS IN TWO TYPICAL HOUSES.

It is unnecessary to enter into a detailed description of the work as observed in progress in all or in any large number of the packing houses. But in order to aid the reader to visualize what was observed, fairly complete accounts are given of the operations in one new house fitted with modern machinery and accessories and in another new house operated entirely without machinery or mechanical accessories. They are both well situated on railroad sidings in good orchard districts, and they packed more than 100,000 boxes each in 1916.

House with machinery.—The house operated with machinery has a floor space of 100 by 188 feet, but has no receiving platform. The roof extends over the driveway, so that the loads at the receiving doors are under protection. The fruit was received and checked in at three doors. On the receiving side the floor is about the same height as a wagon bed, and on the opposite side of the building the car-loading plaform is continuous with the floor of the house and is under roof. Thus the main floor is at a sufficient height to allow a partial basement, and with some excavation this substory has been converted into a box-making department, and when needed it is also used for temporary storage for loose fruit. A driveway excavated beneath the main floor permits vehicles to pass entirely

through the substory, either to deliver fruit or to load boxes for delivery to the orchards. The boxes were owned by the house and were charged out to the growers, and were credited in when returned with loose fruit, so that the grower was debited only with any balance which might show against him at the close of the season.

The hauling was done largely by motor trucks, but wagons also were used. The truckers worked on contract with the house, but all hauling charges were a debit against the grower. The fruit was placed from the vehicles directly on gravity conveyors which deliver the boxes at any position in the house, determined by the length and direction of the track. The stacks were placed five boxes high and trucked to position on the floor. This house had at times more than 10,000 boxes of loose fruit on the floor and in the subbasement.

The machines and accessories occupied a space 50 by 60 feet and were placed at about the center of the building, transverse to the longer dimension, and nearer the side next the railroad, so that the packed fruit was delivered from the nailing presses at a point immediately in front of a door leading to the car-loading platform. This door is at the center of the building line. Three sizing machines (see fig. 4) were in use with gravity conveyors immediately back of each line of bins, so that the packers with one step could set the boxes on them. These tracks led directly to the presses. The three machines were side by side and were so spaced that four lines of conveyors served them all; that is, there is one conveyor on the outside of each of the two outer machines and one in each interspace. By a 90-degree curve the outer conveyors were brought to deliver the boxes at the same position as the short conveyor in the next interspace. A box press was placed at each of these positions, so that the fruit could be placed directly upon it from the conveyors.

At the head of each machine was a short track on which fruit was placed in convenient reach of the feeder. A roller conveyor was suspended directly over the center of each machine, and on this the empty boxes intended for the packed fruit were placed, so that they were in convenient reach of the packers at all times. A short conveyor extended from each press to the assembly space in front of the door above mentioned.

The organization of the packing floor consisted of one general foreman, who was league inspector for the house; one assistant, who managed the floor; one receiving clerk; two helpers, who put the fruit in the stacks; one trucker, who delivered the boxes to the three machines; one man, who put the boxes on the short tracks for the feeders; three feeders (one for each machine); 18 sorters (six to each machine, mostly women); 15 packers; two lidders; and one helper, one assembler, and one checker of packed fruit. Forty-eight persons were actually engaged in receiving, trucking, sorting, grading, and pack-

ing the fruit and delivering it to the men who put it into either the storeroom or the cars. The output was averaging 1,800 boxes per day. There were two storerooms for packed fruit, one on each side of the assembling space and facing on the car-loading platform. These were 45 by 64 feet but were inadequate for the needs of the house.

House without machinery.—The house operating without machines and accessories, is a new structure 100 by 100 feet, built on sloping ground with a basement storeroom occupying a space 50 by 100 feet immediately below the operating space and on the side of the building next to the railway tracks. The floor of this room is level with the car-loading platform. The fruit is received at three doors on the upper side of the building, and, as no gravity carriers are used, it is handled entirely by men. The driver placed the boxes on a shelf across the doorway, level with the top of the wagon bed, and from this position two men removed and stacked them. The loose fruit in this house occupied more than half the main floor, and at times there were more than 20,000 boxes on hand, stacked six high.

The operating floor was 48 by 54 feet, situated in the center of the space at the side farthest from the receiving doors. The packers' tables were placed transverse to the larger diameter of the space and 12 feet from center to center. The tables are 10 feet long, 3 feet wide, and 30 inches high. They are of frame construction, covered with canvas, and divided into four sections each by strips across the top. The canvas sags between these strips and forms four divisions in each table. These tables were set end to end, thus forming long lines. The two outer lines were 40 feet long and the two inner lines 20 feet long, making 12 table units in all. At the end of the two shorter lines were placed the press and lidder's supplies, and short wooden slides extending about half way up the floor space were used for running the packed fruit to the press.

Each table unit had at one side a small sorter's table 18 by 30 inches. On this was poured one box of fruit at a time and one sorter worked at each of these small tables. He removed the culls into a box at his side, separated the fruit into the three standard grades and partially sized it. Thus he used two of the divisions in the packer's table for Extra Fancy and two for Fancy, these being separated into the larger and smaller sizes. The C grade was removed and placed in boxes for packing later.

One trucker delivered the boxes of loose fruit to all the sorters and removed the culls. Each sorter poured the fruit on his table. Two men selected and furnished empty boxes to the packers, checked the packers' cards, removed the finished boxes, put them on the slides, and ran them to the press. The lidder took the boxes from the slides, nailed on the lids, and placed each box in a chute which carried it

to the basement storeroom. A boy at the press stamped the boxes while the lidder was nailing them and the checker made his entry at the same time. The boxes went down the chute and on a gravity track which carried them along the side wall, where they were taken off, assembled, stacked, and labeled.

All of this work was done by contract and the force consisted of one foreman (the contractor), three men receiving, checking, and stacking the fruit in the house, one trucker to supply the sorters, 12 sorters, 20 packers, two tenders for packers, one lidder, one lidder's helper, and one checker of nailed boxes. This list does not include the storeroom and car-loading forces. A statement of the daily pack was not secured, but the contractor stated that he was putting out 8,000 boxes per week.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917